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ABSTRACT

Research among college students has shown that the study of mathematics generates anxiety reactions among students who are not necessarily highly anxious in other situations. Because high levels of anxiety can devastate a student's ability to perform, a math anxiety workshop was field tested in 1993 at the Mohave Valley Campus of the Mohave Community College (MCC) in Arizona. The workshop was offered in 2 sections and was attended by 30 students. The program, based on the findings of a study about the needs of students with math anxiety, concentrated on preparing students for math tests and the study of mathematics through reducing time pressures, reducing the amount of material to be memorized, increasing homework load to increase proficiency, and utilizing relaxation techniques. Instructors were encouraged to participate in assessment and placement of students, address different learning styles, and reduce anxiety levels in classrooms. Exam anxiety was to be reduced through open note or open book exams, group or team exams, take home exams, providing students with study sheets, and replacing long, periodic exams with short, daily quizzes. (Extensive appendixes include the following materials from the workshop: descriptions of audio-visual materials used for motivation, instruction, and relaxation, Math Test Anxiety Scale assessment tool, and positive statements for academic success.) (MAB)

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MATH ANXIETY WORKSHOP 1993

by

Wulf Hinrich Bisse

A Program developed for the Math Anxious Student at all levels, but predominantly at Developmental Levels.

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Northern Arizona University
Center for Excellence in Education

Spring Semester 1993

JC 950 401

ABSTRACT

MATHEMATICS ANXIETY:
A MULTI-METHOD STUDY OF CAUSES AND EFFECTS
WITH COMMUNITY COLLEGE STUDENTS

WULF HINRICH BISSE

The purpose of this multi-method study was to identify, analyze, and assess the factors which influence student anxiety in mathematics. Responses were obtained from a pre- and post- Math Test Anxiety Survey (MTAS), from a focus group interview with 14 students, and individual interviews with 10 students. The Math Test Anxiety Survey was utilized to identify math-anxious students at the beginning of the research period, but also at the end of the research period to find out if any exposure to developmental mathematics over the length of a summer session had any influence on students' math test anxiety. Since the pre-, the same as the post-, MTAS scores were compared with achievement scores of mathematics tests, this study also revealed a correspondence between math test anxiety and math test achievement.

The focus group interview and the individual interviews helped to establish categories and sub-categories, which in turn permitted the placement of students' responses into tables and matrices. A triangulation/convergence of the findings was subsequently conducted. For the triangulation/convergence process the data from the three data

collection strands were converted into magnitudes. Thus, the qualitative data were quantified as well, which confirmed the true multi-methodological design of this study. All research was conducted at the Mohave Valley Campus of Mohave Community College, Kingman, Arizona, a two-year institution in the rural northwest of the state. The student body was nontraditional, with the typical student being female, significantly older than most college students, and attending part-time.

Within the limits of this study, the conclusion was drawn that the data analyses reflect the perceptions of math-anxious students about eight researched categories, responsible for mathematics anxiety. The eight categories were: Math Tests, Algebra, Instructor/Teacher, General Reasons, Assessment and Placement, Other Students, Homework, and Symptoms. As a result of the above-mentioned pre- and post-surveys, and, in addition to the findings of the eight categories, the profile of a math-anxious student, in terms of what worries and concerns about math tests are on his/her mind, was developed as well. The study concluded with a number of recommendations, which were supported by the findings and results. The recommendations addressed necessary improvements of the curriculum, assessment, placement, teaching methodologies, and classroom environment.

Recommendations

The following recommendations, supported by the findings and conclusions of this study, are offered.

How Students can Battle Math Anxiety

One of the major causes of math test anxiety is to worry about what and how others do and how oneself is doing. Yet, it would be foolish to recommend: "Stop worrying!" The questions would then be: "How?" The recommendations in this section, therefore, focus more on a hands-on

approach to the problem and measures that can help students to prepare better for math tests and the study of mathematics.

- Reducing Time Pressure: a better time management by calculating roughly how much time is allowed for each test question. In addition, scanning the test for easy problems and doing them first.
- Memorization: this being the culprit of much math anxiety, but still favored by some math educators; can be eased by preparing for a test over several days. Therefore, an information overload the night before the test can be avoided.
- Homework: doing a lot of it, because it builds confidence. It also helps to reduce math anxiety and is part of the learning process. However, it is essential that prior understanding has taken place, which leads to the next recommendations.
- Don't be afraid to ask a lot of questions. Only this can help one to comprehend concepts and processes, especially in algebra.
- In severe cases, it might be necessary to take only one course - mathematics - during a semester. All the attention and concentration focused on one subject is more benefical than repeating a math course several times.
- Attitude: not to get "hung up" on one tough problem and then giving up. Instead, to move on to the next one and watch in amazement how it "clicks" later.

- Meditation and breathing techniques have been used by research subjects of this study. A recommendation to that extent, however, includes also to see a professional in that field.

These recommendations were collected during the interview sequence; they all come from math-anxious students.

What Mathematics Educators Can Do

This study presented evidence that mathematics educators need to take a close look at methodology and deliverance. The majority of research subjects reported that math teachers/instructors in the past were not able to explain or had not been supportive. Several of the following recommendations come, again, directly from students who participated in this study.

- Math educators have to be involved in the assessment and placement process.
- In the classroom, they need to address different learning styles. For example, the tactile/kinesthetic learner requires hands-on learning opportunities, especially in algebra.
- Math educators need to cooperate with toy/game designers to develop manipulatives - toys, video games - which help to teach the principles of algebraic operations during pre- and elementary school years.
- They need to develop hands-on devices which teach the concepts of signed numbers, variables, algebraic equations, and factorization. Wouldn't it revolutionize the ways and methods algebra is taught, if somebody invented manipulatives that demonstrate the mechanics and logic of, for example, the

subtraction of two negative numbers or the division of one fraction by another?

- Together with technical communicators, mathematics educators need to improve instructional materials by using graphs and step-by-step descriptions of algebraic operations, similar to technical operation manuals.
- Finally, in this context, math educators need to collaborate with linguistic specialists to approach the teaching of algebra as the teaching of a foreign language.
- Math teachers need to create an informal, relaxed classroom atmosphere.
- Math educators, together with psychotherapists and audio/video specialists, need to develop workshops/seminars for mathematics teachers and students which help them to deal with mathematics anxiety. An example is the "Math Anxiety Workshop 1993" (Appendix E) developed by this researcher.
- Teachers of mathematics should be available for students prior to registration, so that students can discuss teaching methods and styles with them.

In conjunction with student advisors, math teachers should evaluate and discuss:

- assessment test scores,
- mathematics backgrounds of the students and proper placement, and
- students who only need a short refresher course instead of a semester-long remedial math course.

How to Reduce Math Anxiety in a Testing Situation

One of the great concerns in this category is, as mentioned earlier, to have enough time. Enough time means different things to different students. It is recommended to allow enough time for the slow test-taker and design special exercises for those who finish earlier. Furthermore, "racing" through a test should be discouraged and emphasis be put on thoroughness and good time management. Other recommended measures to reduce math test anxiety from the educator's point of view are:

- to permit the use of note cards or notes,
- to give open-book tests with problems that cannot be answered by copying from the book,
- to give group or team tests,
- to give take-home tests,
- to give the students specific instructions and study sheets prior to a test, and
- to replace long periodic tests with short daily quizzes.

Helping Students through Group Work

The recommendations for this topic are as follows:

- Students should be permitted to work together on in-class exercises, since learning from a non-authority figure might make a difference.
- Group work should be fostered, since it is modeled after real-life situations in the work world.
- Communication among peers should be encouraged, where appropriate, because problem solving can be accomplished in different ways.

- Group work should be promoted on tests as well, since engineers and scientists seldom work in a "lone ranger" testing environment.

Recommendations for Curriculum Specialists and Administrators

The majority of the students at Mohave Community College are nontraditional or returning students. This group requires extra care and consideration. Recommendations from this group, recorded during the interview sequence, are directed towards curriculum specialists, and student services administrators.

- The college should design and offer preparatory sessions or courses for returning students who have to take the assessment test.
- A different assessment test should be given to those who have been out of school for a long time.
- An item analysis of the assessment test results should be employed to allow for a better placement.
- Different curricula should be developed for the returning student.
- Assessment testing should be abandoned in favor of an individualized assessment and placement system.
- The college should arrange for showcasing sessions of math teachers or permit auditing during the semester to give students the opportunity to choose the math teacher who best fits their needs.
- For students who just need to get started in mathematics again, who just need a quick review, short courses of a few

days to a few weeks should be offered to avoid boredom and frustration during a semester-long course.

Let the Music Play

The last recommendations, supported by the findings and conclusions of this study, have a special tone to them; they are dealing with the classroom environment.

- Chairs and tables should be arranged in clusters, groups, or round table formation to break the utilitarian monotony of the standard classroom.
- Walls should be painted with soothing colors instead of hospital-like whites.
- Finally, soft background music, especially during tests, should help to break the math-anxious tension.

Interestingly enough, this researcher has used classical music on occasion in the past during finals. Without recording observations at that time, it can be said that former students still remember and mention this as a pleasant experience.

INTRODUCTION

Why do students have math anxiety? This question aims at an age old problem in education. The answer is, as in so many similar problems, not easy to be found.

At some point, a negative experience with math must have occurred. It may have been a move or an illness, or perhaps a family trauma, such as a death or divorce. Or maybe it was a poor relationship with a teacher. In any event, something happened that caused the student to miss some basics. And mathematics is a subject that builds on knowledge. So when some basic building blocks are lost, the student's math experience becomes repeatedly disappointing, and the student's view of math develops into a narrow, dismal scenario of what never or always happens. Anxiety, perpetual tardiness, indifference, boredom, poor conduct in the classroom, and endless excuses for not learning math are the result.

As, Sembera and Hovis (1990) observed, emotions have taken over the learning process. These responses to frustration lead to "giving up." These students have chosen to stunt their own growth by not willing to try and not willing to risk ... a classic fear of failure.

Arem (1993) stated that high levels of anxiety can devastate a student's ability to perform, resulting in poor academic progress

and high dropout rates. Research among college students has shown that the activity of math itself generates anxiety reactions among students who are not necessarily highly anxious in other situations. One study at a large midwestern university disclosed that one-third of all students who requested behavioral counseling complained of anxiety related to math. (Suinn, 1972)

Worrying about academic performance or achievement usually is manifested in negative thoughts, and most regularly includes test anxiety as well. There are basically two different types of test-anxious students. The first are the students with relatively poor study skills. They have trouble learning course material in a way that makes it meaningful and memorable. The second type are the students who have a reasonable repertoire of learning and study strategies. These students know how to study and learn the material, but they have problems when they have to demonstrate that knowledge in testing or in other evaluative situations.

Weinstein and Hagen (1993) believed for many years that test anxiety was manifested only in physiological symptoms. But they found out that anxiety has two major components: cognitive and physiological. After identifying the type of anxiety a student may be experiencing, the next step is trying to help the student do something about it. The very same counts for the math anxious student in general. He/she needs help fast, to make the start of the journey, called college education, easier and more enjoyable.

Over time, systems have been developed to make the learning easier. One of them is called "Optimalearning" and was developed by I. Barzakov after he escaped from Bulgaria in 1976.

Optimalearning uses several techniques involving art stimuli, classical music, indirect imagery, and visualization.

The Math Anxiety Workshop 1993 which has been developed uses similar techniques including: relaxation through music, audio support, video presentations, excerpts of box office movies, non-threatening fun tests and exercises, discussions, motivational audio and video material, brain power and memory boosters.

The following material will be presented in chronological order.

The Math Anxiety Workshop 1993 has been field tested at Mohave Community College, Mohave Valley Campus, during the Spring Semester of 1993. The workshop was offered in two sections, MATH 052 Part I and II, and was attended by thirty students. The workshop was well received, and the students earned .50 semester credit hours. For the coming fall semester, the Math Anxiety Workshop is scheduled again for the Mohave Valley Campus and in addition, for the Kingman Campus. Moreover, it is currently under discussion to make this workshop a part of EDU 150 College Study Skills at Mohave Community College.

MATH ANXIETY WORKSHOP 1993

by Wulf H. Bisse

Story Line

Scene 1: Greeting, Introduction, Introduction of Host and Participants, Agenda, Math Anxiety a common cause.

Scene 2: Relaxation with Music: Enigma MCMXC A.D. tape. Lights turned down, eyes closed, following the rhythm of the music.

Scene 3: Overheads: The Far Side (1) and Math! A Four Letter Word (5). Discussion of overheads.

Scene 4: Video: Math! A Four Letter Word. Discussion.

Scene 5: Mathe Magics Fun Test. Solutions, discussion.

Scene 6: Audio-cassette: Boost your Brainpower.

Scene 7: Movie: Stand and Deliver. Motivational. - You can do it.

Scene 8: Math Test Anxiety Scale. Assessment, discussion.

Scene 9: Cognitive Interference Questionnaire. Assessment, discussion.

Scene 10: Tension/Apprehension Test. Assessment, discussion.

Scene 11: Video: Test Taking Without Fear. Discussion.

Scene 12: Assessing Perceptual Learning Channels. Exercise, discussion.

Scene 13: Movie: Summer School, Entertainment, relaxation.

Scene 14: Math Test Anxiety Reduction Checklist. Exercise, discussion.

Scene 15: Audio cassette: Super Memory.

Scene 16: Positive Statements for Academic Success. Exercise, discussion.

Scene 17: Fun Exercises. The Missing Penny, etc. Solutions, discussion.

Scene 18: Movie: Teachers.' Fun, entertainment.

Scene 19: Handouts: Algebra on the Job. Discussion.

Scene 20: Video: College Algebra. In Simplest Terms. Language of Algebra. Discussion.

Scene 21: Video: Turn on the Human Calculator in you! Fun with Math, surprising methods.

Scene 22: Closing remarks and discussion.

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By Wulf H. Bisse

MUSIC

1. Enigma MCMXC a.D. 1990 Virgin Records Ltd.

   I. The Voice of Enigma

   II. Principles of Lust

   III. Callas Went Away

   IV. Mea Culpa

   V. The Voice & The Snake

   VI. Knocking on Forbidden Doors

   VII. Back to the Rivers of Belief

   Time: Approximately 40 Minutes

2. Inner World

   1988 Relaxation Products C. 1992 T239A03

   Time: Approximately 50 Minutes

Music used for relaxation and background.

MATH ANXIETY WORKSHOP 1993

by Wulf H. Bisse

VIDEOS

1. Math! A Four Letter Word

   1/2" VHS Time: 19:36 Minutes

Public Films Inc.
Rt. 1, Box 282-E43
P.O. Box 1689
Wimberley, TX 78676
Tel. (512)847-9066

2. Stand and Deliver (Movie)

   -excerpts- Time: Approximately 20 Minutes

3. Test Taking Without Fear

   288V Time: 15 Minutes

Educational Video
1401 19th Street
Huntsville, TX 77340

4. Summer School (Movie)

   -excerpts- Time: Approximately 20 Minutes

5. Teachers (Movie)

   -excerpts- Time: Approximately 20 Minutes

6. College Algebra:

   In Simplest Terms

   Language of Algebra

   VHS Time: 30 Minutes

The Annenberg/CPB Collection
901 E Street NW
Washington, DC 20004
Tel. (202)879-9600
Developed by
The Consortium for Mathematics and HS Applications (COMAP, INC.)

7. Turn on the Human Calculator

VHS Time: Approximately 47 Minutes

Media Arts Internationale
1875 Campus Commons Drive, Suite 200
Reston, VA 22091

Pages 17-22 have been excluded due to copyright restrictions. They are from "Math! A Four Letter Word" a multimedia presentation.

VIDEO

Math! A Four Letter Word

Public Films Inc.
P.O. Box 1689
Wimberly, TX 78676

A lot of information is packed into the twenty minute film. The show opens with students, who are repeatedly shown in the movie at different stages of their travel through fear, honestly airing their old and new feelings toward mathematics. These students are not afraid of being straightforward, and they do not mince words. Very important is their diversity in age, sex, and race, which provides a fitting model for everybody dealing with math anxiety. Some of the common causes of math anxiety are presented (low parental expectations when it comes to mathematical performance in school, the fear of forgetting the material studied, the memories of previous failures, and the pursuit of the perfect answer as the only goal when working on math). During the movie, a list of mathematical myths (such as the existence of a "mathematical mind" and the fact that "men are better than women in math") is brought up, and very practical suggestions are given. For sure, any person with some common sense could have come up with the suggestions presented, but it is difficult to have any common sense when fear sets in. And this is an excellent point discussed in the movie: face the fear, be ready for it, acknowledge it. One of the students is presented facing an anxiety attack while getting ready to take a test. This example further clarifies the suggestions given by a psychologist. The movie closes on a positive note,

emphasizing the fact that math anxiety can be overcome with some hard work!

Participants in workshops really enjoy Math! A Four Letter Word because they can relate to the people interviewed, and they are relieved to see someone in a movie who has the guts to say "math makes me physically ill." At this point, the participants relax (and giggle in relief) because they get the feeling that the movie will not ridicule their fears and will not put them down. Most of the students found the suggestions given in the movie to be very useful.

MATHE MAGICS FUN TEST

(Relax!)

1. A sailor went to three casinos on the same night. At the Tropicana, he doubled his money and then lost $30; he took his remaining money and went to Caesar's Palace. There, he tripled the money with which he entered and then lost $54. At that point, he took his remaining money and went to Aladdin's. There he quadrupled the money with which he entered but then spent $72. He spent no more money, and when he returned to his room he had $48 left. How much money did he have before he went to the casinos?

2. If two typists can type two pages in two minutes, how many typists will it take to type 18 pages in six minutes?

3. What is the number that is one-half of one-quarter of one-tenth of 400?

4. Eighteen people, numbered 1-18, are equally spaced around a round table. What is the number of the person directly across from the person numbered 6?

5. A wagon train had ninety-six wagons each carrying the same number of people. When twelve wagons broke down, each of the other wagons had to carry one more person. How many people were in each wagon originally?

6. The SAME three-letter word can be placed in front of the following words to make a new word:

___LIGHT ___BREAK ___TIME

Sources: Mensa MiniTest, Mathematics Teacher (NCTM)

7. Bobbi and Ellie each chose a secret five-digit number. Ellie's number was larger than Bobbi"s. The sum of the numbers was 50581, and the difference was 12,965. When each entered her number in a calculator and looked at it upside down, what did she find?

8. As I was going to St. Ives
I met a man with seven wives.
Every wife had seven sacks,
Every sack had seven cats,
Every cat had seven kits,
Kits, cats, sacks, and wives,
How many were going to St. Ives?

9. Sara and David were reading the same novel. When Sara asked David what page he was reading, he replied that the product of the number of the page he was reading and the next page number was 98,282. What page was David reading?

10. Can you move just one digit to make this statement true?
101 - 102 = 1

Sources: Mensa MiniTest, Mathematics Teacher (NCTM)

AUDIO

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A Prevention Magazine Audiocassette

Rodale Press, 1989

- Open your creative potential by learning how to communicate with your "right" brain.

- Learn specific tips to get your brain in gear so you can really concentrate.

-Experience autogenic training--a technique that clears your mental decks and revs up your cerebral engines.

MATH ANXIETY TESTS

Perhaps the best known instrument for measuring math anxiety is called the Mathematics Anxiety Rating Scale (MARS). It comes in three versions: for elementary students, junior and senior high students, and adults. Each consists of about 98 questions which have been tested for reliability. These tests may be obtained from the Rocky Mountain Behavior Sciences Institute, Inc., P.O. Box 1066, Fort Collins, Colorado 80522. Instruction for administration, scoring, and copies of the instrument are provided for a nominal fee.

Identifying Math Test Anxious Students

Sometimes, students feel anxiety only when taking math tests. Test anxious students are often preoccupied with thoughts about how poorly they do, how other people are doing, what everyone will think, how they will probably fail, and so on. They spend more time worrying than working.

There are two tools that can be used to help identify test anxious students and the kinds of thoughts they have. One is the "Test Anxiety Scale" (TAS), and the other is the "Cognitive Interference Questionnaire" (CIQ).

The TAS and the CIQ have been altered so that they will pertain to math anxiety. On the altered TAS **(Math Test Anxiety Scale)**, score 1 point for each "True" answer to numbers 1,2,4-14, 16-25,28,30-32, and 34-37, and 1 point for each "False" answer to 3,15,26,27,29, and 33.

On the altered **Cognitive Interference Questionnaire,** first give the students a math "test" or "quiz". A few problems under a ten or fifteen minute time limit is plenty. Then collect the problems and hand out the questionnaire which follows. To score the completed questionnaire, simply add the numbers that the students places in the blanks left of the statements.

With both, the higher you score, the more math and math test anxious you are.

The altered TAS and CIQ, which appear as follows, were based on the Test Anxiety Scale and Cognitive Interference Questionnaire which appear in Stress and Anxiety (Vol. 5), C.D. Speilberger and I.G. Sarason (Eds.), Washington D.C.: Hemisphere, pp. 198-201 and 203-204.

Name: _____ Date: _____

Course: _____ Score: _____

Math Test Anxiety Survey

In front of each statement, please circle the "T" for true or the "F" for false.

T F 1. While taking an important math exam I find myself thinking of how much brighter the other students are than I am.

T F 2. If I were to take an intelligence test, I would worry a great deal before taking it.

T F 3. If I knew I was going to take an intelligence test, I would feel confident and relaxed beforehand.

T F 4. While taking an important math exam I perspire a great deal.

T F 5. During math examinations I find myself thinking of things unrelated to the actual course material.

T F 6. I begin to feel very panicky when I have to take a surprise math exam.

T F 7. During math tests I find myself thinking of the consequences of failing.

T F 8. After important math tests I am frequently so tense that my stomach gets upset.

T F 9. I freeze up when taking math examinations.

T F 10. Getting a good grade on one math test does not seem to increase my confidence on the second.

T F 11. I sometimes feel my heart beating very fast during important math tests.

T F 12. After taking a math test, I always feel like I could have done better than I actually did.

T F 13. I usually get depressed after taking a math test.

T F 14. I have an uneasy, upset feeling before taking a math test.

T F 15. When taking a math test my emotional feelings do not interfere with my performance.

Math Test Anxiety Survey

T F 16. During a math examination I frequently get so nervous that I forget facts I really know.

T F 17. I seem to defeat myself while working on important math tests.

T F 18. The harder I work at taking a math test or studying for one, the more confused I get.

T F 19. As soon as a math exam is over, I try to stop worrying about it, but I just can't.

T F 20. During math exams I sometimes wonder if I'll ever graduate.

T F 21. I would rather write a paper than take an examination for my grade in a course.

T F 22. I wish math examinations did not bother me so much.

T F 23. I think I could do much better on math tests if I could take them alone and not feel pressured by a time limit.

T F 24. Thinking about the grade I may get in a math course interferes with my studying and my performance on tests.

T F 25. If math examinations could be done away with, I think I would actually learn more.

T F 26. While taking a math exam, I have the attitude "If I don't know it now there's no point worrying about it."

T F 27. I really don't see why some people get so upset about math tests.

T F 28. Thoughts of doing poorly interfere with my performance on math tests.

T F 29. I don't study any harder for final exams than for the rest of my course work in math.

T F 30. Even when I'm well prepared for a math test, I feel very anxious about it.

T F 31. I don't enjoy eating before an important math test.

T F 32. Before an important math exam I find my hands or arms trembling.

Math Test Anxiety Survey

T F 33. I seldom feel the need for cramming before an important math test.

T F 34. The school ought to recognize that some students are more nervous than others about math tests and that this affects their performance.

T F 35. It seems to me that math exam periods ought not to be made the tense situations which they are.

T F 36. I start feeling very uneasy just before getting a math test back.

T F 37. I dread math courses where the professor has the habit of giving "pop" quizzes.

The altered "Math Test Anxiety Survey" above is based on the "Test Anxiety Scale" which appears in Stress and Anxiety (Vol. 5). C. D. Speilberger and I. G. Sarason (Eds.). Washington, D.C.:Hemisphere, pp. 198-201.

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AUDIO

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Remember names and dates - Learn true concentration - Employ sensory recall.

Mind/Body Healing Tapes

A Prevention Magazine Audiocassette

Rodale Press, 1988

- Discover the secrets to keeping your memory sharp at any age.
- Learn easy techniques to instantly recall names, numbers, reading matter.
- Find out how to eliminate endless searching for keys, glasses, and other mislaid items.
- Learn how to relax so "on-the-tip-of-your-tongue" memories flow back to you.

Pages 46-64 have been excluded due to copyright restrictions. They are from *Conquering Math Anxiety*.

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